# Presenting Indian Science and Technology Heritage in Science Centres (Part 1)

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## Abstract

*The Indian Civilization has a long recorded history of scientific culture that goes back to more than 5000 years and with China; India is one of the longest surviving civilizations who have made profound contributions to the growth of science and technology. Yet when it comes to portrayal of India's contribution to science and technology, it is completely neglected or over looked. One finds mainly a Eurocentric perspective in history of science; typically, it starts with Greece, neglecting the influences of others upon Greece and then it fast forwards many centuries to the renaissance period to portray modern science to be the sole contribution of Europe.*

*The objective of developing the gallery "Our Science and Technology Heritage" at the National Science Centre, Delhi was to try and correct the portrayal of Indian civilization and present a true picture of what its contributions is in the field of science and technology. The gallery covering an area of 1100 square meters has adopted a mixture of a typical museum and science centre presentation approach in its presentation. Considering the vastness of the subject and also the diversity of ancient Indian contribution in different fields of S&T, the article would require a vast space to cover the whole subject and therefore it was prudent to break the article in two parts this being the first part. The second part of the article will cover all other subjects not covered in this part and will include subjects like mining and metallurgy, enduring art and architecture, traditional crafts, etc. while this part, the part 1 of the article, covers Indian contributions in the field of mathematics and philosophy, Harappans technological achievements, astronomy, alchemy and medicine, and other significant technological contributions that India made. This article also presents how this gallery was developed and the basis of choice of subjects covered and also the mode of the presentation.*


## Genesis

Since the dawn of human civilization, different cultures from across the world have contributed to the growth of science and technology, often through interactions. Science and technology in India originated and developed independently, and its achievements are quite as profound as their counterparts in other advanced cultures. Indians developed one of the earliest written scripts (the Indus Scripts)[1] albeit un-deciphered completely, however there are now renewed efforts for deciphering the same[2]. Indians built urban towns, with residential complexes and wastewater systems, way back in 2500 BC. Ancient Indians created the concept of a perpetually moving machine in 624 AD and also produced the Delhi Iron Pillar[2A] that has remained rust-less for the past 1500 years. They discovered the magic number zero and were the first to use decimal place value number system way back in 500 AD. Cotton Gin, an Indian invention, as credited by Joseph Needham, was the forerunner of all geared machines that subsequently paved the way for the west to bring about an industrial revolution. Indians also created enduring architectural constructs that have become eternal world heritages. They smelted zinc, which require precise metallurgical knowledge, on industrial scale and produced thousands of tons of zinc over hundreds of years[3]. There are several other contributions that scholars like Joseph Needham credits India to be the first to make, which include: alcohol distillation, use of scotch-bow, crank, draw-bar, milling and spinning-wheel[4] etc. Just as in other countries, including the western civilization, the progress of S&T in India has been anything but uniform in time and space. Periods of rapid advance have alternated with long periods of stagnation and even of decay. Science and technology in India closely intertwined with culture and philosophy, tempered with wisdom has flourished for centuries. However, strong influences of foreign invasions subdued it. We therefore had to rely on diverse reference materials and research content for the development of the gallery for portraying S&T Heritage of India in a manner easily comprehendible by the visitors.

## The Challenges for Developing HistoricalExhibitions in Science Centres and the Approach Adopted

The challenge for the science centres to show case S&T culture of India spread across a vast span (more than 5000 years) in the most authentic manner is largely due to the diverse views, some of which are contrary to each other, expressed by different scholars. The challenge can best be appreciated in the expression

of Dr Frank Winter, a Smithsonian Institution (National Air and Space Museum) Curator, and an expert on the history of rockets, arms and ammunitions, who describes the research on Indian science and technology history as a "historian's nightmare". Fortunately for us we could develop this gallery laying the foundation on the scholastic research works already done by the Council while developing the Festival of India (FOI) exhibition in the 1980s. Large part of this exhibition was dedicated to the Indian S&T Heritage. This exhibition after successfully touring different science centres across USA and other countries finally was brought back to India. We therefore had a wealth of information and research material and also artifacts that we could use for the development of the gallery "Our S&T Heritage" at National Science Centre, Delhi (NSCD). The FOI exhibition was created in the early 1980s and its content was largely based on the research information and content available at that point of time and therefore the exhibition did have its own limitation more so since the field of archeo-metallurgy, archeo-astronomy and history of S&T in India has evolved rapidly and scores of research materials, books and monograms in different fields have been published. Several scholarly publications have also appeared in the "Indian Journal of History of Science" a quarterly journal brought out by INSA, which has also published books and periodicals and journals on the history of science and technology in India. Dholavira, a site belonging to the Indus Civilization has been excavated during the 1990s by Dr Bisht and these excavations have shed new insights into the Indus Civilization. Incidentally Nehru Science Centre, Mumbai one of the units of National Council of Science Museums, in the year 2006, opened a new gallery "Our Technology Heritage" and for developing this gallery lot of research was carried out for collecting research information and content and contacts were also made with leading scholars both national and international working in this field. This research content and information was highly useful in the development of the gallery at Delhi. In addition to the above mentioned research content further research was also carried out at NSCD and all this research content have been referred extensively while designing and developing the gallery. Besides these materials we also relied on other research publications from scholars like Dr Paul Craddock of the British Museum, who has done monumental work on archeo-metallurgy including zinc smelting from the Zawar mines, Dr R Balasubramanium, IIT, Kanpur, whose "New Insights into the Delhi Iron Pillar", and his works on "Saga of Indian Cannons" has shed new light into the remarkable technological acumen that the ancient Indians possessed in forging and iron technology, Prof Ranganathan and Dr Sharda Srinivasan, of IISC Bangalore who have brought out a scholarly book "Legendary Wootz steel" that talks about the ancient Indian contributions in the field of iron and steel with special emphasis on Wootz steel also served as useful reference. We have also been privileged to get support and obtain information from various scholars both from India and abroad for developing this gallery.

## *A Need for Needham like Publications for India*

Notwithstanding the volumes of information and research content that is now presently available in different sources related to the history of science and technology in India, yet the acceptance of ancient Indian contributions in science by the international community is far from what is desirable. This is mainly on account of the fact that there is no single scholarly publication that dwells on the history of science and technology in India. However, in the case of China, Joseph Needham, a leading scholar at Cambridge, made it his life's work to document China's history of science and technology ("Science and Civilization in China, Cambridge University Press" in over 30 volumes) (http://www.nri.org.uk/science.html). By the time he died at age 90, his works has transformed the study of China forever. The Needham Foundation has continued his monumental work after his death, and has been expanding the series with new volumes. No such singular effort has been made for documenting the contributions of India. Although in the recent past Infinity Foundation, an US based organization, has instituted leading scholars to publish a 20 volumes series of books under the project title HIST (History of Indian Science and Technology)[5], out of which some publications have already been completed, yet much more is required to be done to reach anywhere near what Needham did for China. A series of essays on ancient science and technology in India written by well known authors also now find a place on the net[6] which also helps in spreading awareness among international audience.

Today, every research library on China, and every major library on science and history, has the Needham collection as important reference works. Every serious China scholar has respect for this work, and its impact on the image of China has been extraordinary. This impact has also trickled down to the depictions in schools and the general media. No longer is it easy for anyone to denigrate Chinese civilization as being devoid of rational thought, scientific rigour, or the quest for indigenous progress. It is because of this that most students have learnt about the ancient cities of the Middle East and China. But due to the absence of such scholarly work as that of Joseph Needham on Indian contributions in science and technology, many people

do not know even the basic facts about the ancient Indus Valley Civilization, one of the oldest and most advanced civilizations anywhere in the world. India has over 800 of the 1100 known sites discovered so far in the world yet not many are aware of this rich Indian heritage. Rustless wonder - the Delhi Iron Pillar, that has withstood corrosion for all of 1500 years or so is located in the precincts of Qutab Minar, yet many people even in Delhi are not aware of its uniqueness. It was in this context that a gallery on Our S&T Heritage was developed for creating awareness about the rich S&T Heritage of the country for the public.

Amartya Sen, summarizes the dichotomy that India faces when it comes to presenting its rich science and technology heritage. While referring to the contributions of Joseph Needham and necessity of such scholastic works for India he says, "Fear of elitism did not, happily, deter Joseph Needham from writing his authoritative account of the history of science and technology in China,............... A similar history of India's science and technology has not yet been attempted,............ . The absence of a general study like Needham's is influenced by an attitudinal dichotomy. ............ The need for a work like Needham's has remained unmet"[7].

The need espoused by Amartya Sen for bringing out such monumental works similar to the one brought out by Joseph Needham on China to cover the contributions of India in science and technology got a momentum during the inauguration of Our Science and Technology Heritage gallery at our Centre. This gallery was inaugurated by Shri Jawhar Sircar, Secretary, Ministry of Culture, Government of India, on 21st October, 2009 and on seeing the contributions of ancient India in science and technology displayed in the exhibits, he felt that there should be a series of scholastic publications on the subject and announced that the Ministry of Culture, Government of India would soon take initiatives towards achieving this.

## *Presentation Techniques*

Exploratorium, a path breaking science centre built by the legendary Frank Oppenheimer, has revolutionized the concept of interactive exhibits and the Indian science centres too have adopted his philosophy like all the other science centres of the world, for presenting their science centre gallery exhibits in an interactive way. We therefore encountered another complex issue as to how we should approach presenting the exhibits in "Our S&T Heritage" gallery at NSCD. After series of brain storming sessions with the curators and exhibition officers, we took a consensus decision to present this gallery using a wonderful mix of both the science centre and traditional museum approach. The interactive exhibits used in the gallery were artistically crafted to merge with the traditional museum presentation in the gallery. In the museum like display most of the subjects covered in the gallery are showcased to present a period setting and thus taking the visitor back to the era of the period being covered.

## *The Entry Mural*

The gallery starts with a presentation that is a wonderful mix of both the science centre and museum approach (Fig1&2). A large size mural

Fig..1 The entrance view of the gallery showing inset display of the section on ancient astronomy

Fig. 2. Time line of our S&T Heritage mural exhibit in the entry area showing 6 landmark time lines with supporting digital photo frames and a touch screen multimedia

encompassing land mark developments from the Mehrgarh culture (7000 BC) to the Mogul era (1750 AD) has been displayed with some landmark features of science and technology depicted in the mural. Some of the other important landmark features of the period not covered in the mural are appropriately covered in the accompanying digital photo frames that appear one at a time. A multimedia touch screen computer and a large size display unit supplement the exhibit to cover detailed information on total time span of our S&T Heritage.

## *Technological Traditions of Indus – Diorama*

The next section in the gallery (Fig 3) portrays in a period setting, with artistic elegance, the technological developments of the Indus Valley Civilization. It is for this reason that Harappans have

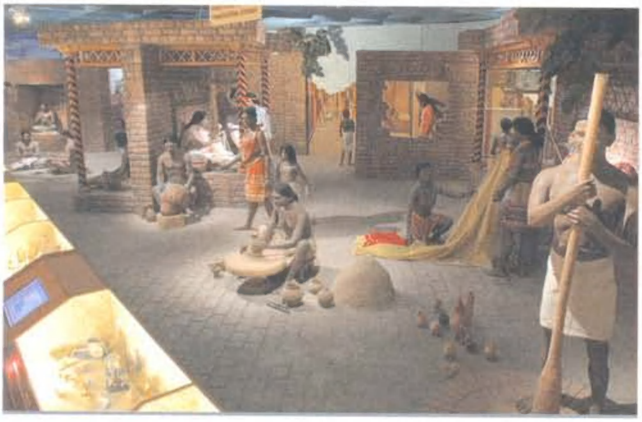

Fig. 3. A general view of the Harappans diorama showing different technological practices of the Indus people

been referred to as remarkably sophisticated and industrialized urbanites of the Bronze Age in south Asia[8]. Important technological traditions of the Harappans have been recreated with life like human figures adopting the references from the works of Kenoyer of the University of Wisconsin[9]. Technologies showcased in the exhibit include: pottery and ceramics, shell bangles, carnelian beads, metallurgy, precision hole drilling in beads, town planning, textiles, drainage, pounding platforms, ship building and dock yard, market place with standardized weights and measures etc. A show case has also been created to display the replicas of pottery and other important material evidence from the Indus valley findings. Two multimedia computers with touch screens have been used in the presentation to show case the technological traditions of the Harappans one each in English and Hindi language.

The Indus Valley Civilization, at its peak during 2600 BC to 1900 BC, knit together more than 1000 cities, towns and settlements scattered across 725,000 sq km of India and Pakistan[10]. The Indus Valley Civilization, also called the Harappan Culture was according to some, the youngest but by far the largest of the three most ancient civilizations. It was noted for wheel turned ceramics, terracotta craft, spinning and weaving, bead-making, and more importantly, copper-bronze casting by the cire-purdue or lost-wax process. Within this civilization flourished many towns and cities including Mohenjodaro, Harappa, Dholavira, Chanhudaro, Kalibangan, Lothal etc which have revealed an agriculture-based economy with granaries and other storing techniques that made for an enriched community life.

The Indus cities show town planning of an amazing complexity[11]. Systematic town planning, fortification of citadel, lower town, elaborate drainage system, establishment of granaries and surplus economy, standardization of brick sizes, weights and measures, use of geometric instruments like right angles, linear scale and plumb bob etc are the principal gifts of the Harappans to the succeeding cultures. The Harappans gave the idea of welfare for the workers by establishing workmen's quarters. City houses in matured Indus Valley stage has been many-storied, palatial, solidly built imposing walls of well-baked bricks with 4:2:1 size ratio, which now forms the basis for modern English and Flemish brick bonding, and supplied with such amenities as good bathroom and lavatories. Besides the straight roads meeting at right-angles, there was a superb drainage system for carrying away rain-water and cesspools for clearing the sewage. Studies have also shown that starting from the Indus Valley Civilization up to the construction of Iron Pillar, India used standard length unit of *angulam* (close to an inch) over a period of almost 3000 years. No other ancient civilization offered civic amenities of such complexity.

## *Mathematics and Early Philosophical Sciences*

The next section (Fig 4) covers the mathematics and philosophical concepts that emanated from India. Here too an inextricable mix of science centre and museum approach has been adopted to present the subject. A process apparently as simple as counting has passed through many stages before reaching the present level of universal acceptance. India gave to the world an ingenious method of expressing all numbers by means of symbols, each symbol representing a value of position as well as an absolute value, a profound and

Fig 4. A general view of the section on Ancient Indian Philosophical concepts and contributions in mathematics

important idea that appears so simple now that we tend to ignore its true merit. George Sarton, the renowned historian of science, known for his work, Ancient science through the golden age of Greece, Cambridge, Harvard University Press, 1952, has observed: *Our numbers and the use of zero were invented by the Hindus and transmitted by Arabs; hence the name Arabic numerals which we often give them.* Al-Khwarizmi (9th century AD), a Central Asian mathematician who worked in Baghdad, played a crucial role in transmission of the Hindu works to the western world through his seminal work on arithmetic. Al-Biruni (11th Century AD)[12] was another exponent not only of the Hindu numerical system, but also of Indian astronomy. Other important Indian contributions that have been adequately covered in this section of the gallery include calculation of the value of pi, and calculating the square and cube roots of numbers, the golden rule of three, Brahma Gupta's important contribution in the solution of second order indeterminate equation that was later recognized by Europe as the Pell's equation. His lemmas in this connection were rediscovered by Euler (1764) and Lagrange. The so-called Pythagoras theorem also seems to have been worked out by the Indians as evidenced in the *Sulbasutra* treatises and therefore the exhibition also covers this aspect which also has been presented in an interactive manner.

A thousand years before the time of Copernicus (1473-1543), Aryabhatta (476 AD) in India made outstanding contributions to astronomy and mathematics. His contributions include: the determination of the diameter of the earth and the moon, the proposal that the earth rotated on its axis to explain the daily motions of the fixed stars; the solution of quadratic equation; defining the trigonometric functions; stressing the importance of Zero; and determining the value of pi up to the fourth decimal place. The tradition of astronomy and mathematics continued in the years to come, preceding similar developments in Europe by a couple of centuries in such areas as determination of the precision of equinoxes, parallax, mean and true motions of planets, permutations and combinations, solving quadratic equations, square root of negative numbers and trigonometrical series brought out by Madhava and others of the Kerala school of mathematics. The twelfth century witnessed the most notable astronomer-cum-mathematician, Bhaskaracharya II. His cyclic (*chakravalaya*) method for solving indeterminate equations of the second order has been hailed by the eminent German mathematician Hermann Henkel as the finest thing achieved in the theory of numbers before Lagrange. Each of these abstract concepts and contributions has been presented in the exhibits in a manner that has an interactive component for the visitor to try his/her hands on.

## *Alchemy- The Rasashala*

Alchemy (the older form of chemistry) is another area in which ancient Indians made profound contributions[13]. It is interesting to note that Joseph Needham claims that earliest distillation of alcohol can be traced back to the archaeological finds at Taxila[14]. Much of ancient chemistry in India grew out of the early efforts to develop an elixir and to turn base metals into gold. The Indian alchemy had two characteristic streams: gold making and elixir synthesis. The two faces of the alchemical practice, the metallurgical and the physico-religious, were superimposed to get a single picture wherein mercury and its elixirs were used in the so-called transmutation of the base metals into noble ones, as well as for internal administration for purifying the body, rejuvenating it and taking it to an imperishable and immortal state. The earliest available documented alchemical text in Sanskrit, *Rasaratnakara* by Nagarjuna was probably part of a larger text *Rasendramangala* written by the same author. Nagarjuna was the most prominent scholar in the field of Indian alchemy. Rasashala (fig 5), a typical


Fig. 5. Exhibit showing a typical period setting of an ancient chemical laboratory the Rasashala

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alchemical laboratory of Nagarjuna which is portrayed in the Gallery, shows a number of special types of *yantras*, used for different chemical purposes like distillation *(patanayantra)*. One of the most important *yantras* the *tiryakapatanayantra* (reverse distillation) was used in zinc smelting and also in the perfume making (fig 6). In ancient India, there was


Fig. 6. Diorama depicting the ancient Indian perfume making process using the reverse hydro distillation techniques

considerable use of cosmetics and perfumery for the purpose of worship, sale and sensual enjoyment. *Brihatsamhita* (500 AD) of Varahamihira deals with *gandhayukti* (blending of perfumes) in 37 verses. The word *sugandhi*, meaning well perfumed, is also used in Rig Veda. Expressions involving the term *gandha* are found in *Taittiriiya Samhita, Maitrayani Samhita, Satapatha Brahmana* and *Taittiriiya Aranyaka*. The ancient traditional method of making the *attar* using hydro distillation is still used at *Kanauj*. Attars of Kanauj are widely acclaimed by the world both as perfumes and medicines.

## Medicine and Surgery

The science of the body and mind, in India, had its origin in the healing art of the Vedic times. This knowledge and practice, called *Ayurveda*, meaning 'Science of Life' originated in ancient India. Although the era in which Ayurveda originated is embroiled in controversy it is fairly certain that it is one of the earliest medical sciences to have evolved globally. *Rigveda* and *Atharvaveda*, the earliest documented ancient Indian knowledge, have references on health and diseases. Ayurveda deals elaborately with measures for healthful living during the entire span of life and its various phases. Besides, dealing with principles for maintenance of health, it has also developed a wide range of therapeutic measures to combat illness. These principles of positive health and therapeutic measures relate to physical, mental, social and spiritual welfare of human beings. Ayurveda is broadly classified under three major categories namely, *Charaka Samhita* (probably authored by Charaka), *Sushruta Samhita* (authored by Sushruta) and *Asthanghrudaya* (by Bhagavata).

The *Charaka Samhita* is believed to have arisen around 400-200 BC. It is felt to be one of the oldest and the most important ancient authoritative writings on Ayurveda. It is not known who this person, Charaka, was or, if indeed, this represents the work of a "school of thought." It could have been from a group of scholars or followers of a man known as Charaka or an original composition from a single person named Charaka. This work is sometimes considered a redaction of an older and more voluminous work, *Agnivesha Samhita* (46,000 verses), which is no longer extant. Dridhabala, living about 400 AD, is believed to have filled in many verses of missing text in the *Chikitsasthana* and elsewhere, which disappeared over time. The study and understanding of several classical treatises on Ayurveda indicate presence of eight disciplines which are generally called "Ashtanga Ayurveda" and these eight disciplines include: Internal Medicine (*Kaya Chikitsa*), Paediatrics (*Kaumar Bhritya*), Psychiatry (*Bhoot Vidya*), Otorhinolaryngology and Ophthalmology (*Shalakya*), Surgery (*Shalya*), Toxicology (*Agad Tantra),* Geriatrics (*Rasayana*) and Eugenics and aphrodisiacs (*Vajikarana*). The language of Charaka Samhita is Sanskrit and its style is poetry. Poetry was known to serve as a memory aid. Charaka contains over 8,400 metrical verses, which are often committed to memory, by the medical students of Ayurveda.

The *Charaka* and *Sushruta Samhitas* present a vivid and cogent account of the medical knowledge and surgical practices respectively and continue to be used in Ayurveda even today. Medical historian D. Guthrie records, *it was in surgery, above all, that the ancient Hindus excelled*. Noted physician, Galen of Pergamum who lived in Rome, made no secret of his borrowing material relating to ointment for the eyes and the Indian plaster from Indian sources. The *Sushruta Samhita* which accords pride of place to surgery describes more than three hundred different operations and 121 surgical instruments (20 sharp and 101 accessory) such as tongs, forceps, scalpels, catheters, syringes, speculums, needles, saws, probes, scissors and the like. Most of the surgical instruments used by Sushruta are quite similar to the modern surgical instruments[15]. The outstanding feats of ancient Indian surgery related to laparatomy, lithotomy and plastic operations. The Sushruta Samhita is regarded as the earliest document to give a detailed account of rhinoplasty (plastic reconstruction of the nose). It was only in the eighteenth century that plastic surgery made its appearance in Europe. This aspect of ancient Indian Surgery has been aptly presented in the gallery in the form of a diorama depicting a typical surgical room of Sushruta (fig 7).

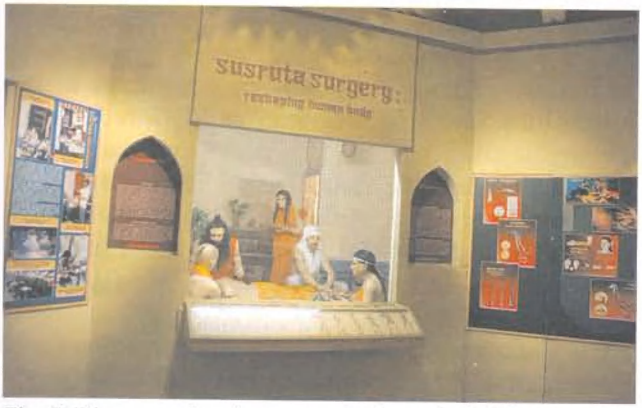


Fig 7 Diorama showing a typical surgical laboratory of Sushruta, with supporting information and display materials

Of the several media coverage that the gallery received in the print and electronic media one that stands out is the coverage on Sushruta's surgery. Just after the inauguration of the gallery a press correspondent from AFP, of all things from the gallery, picked up the *Nose Job* of Sushruta and filed his report and his report was picked up and published by several international and Indian print medias[16] and the coverage credited India (Sushruta) to be the first to carry out the plastic surgery with specific reference to the rhinoplasty, besides touching upon the other highlights of the gallery.

## *Significant Technological Contributions of India*

### *Noria and Saquia*

One of the major additions to the newly developed gallery at NSCD was the Indian Technological contributions in the field of milling, water lifting devices, worm gearing, crank, scutch bow, and spinning wheel[17]. Joseph Needham in his Science and Civilization in China, besides concentrating on China, also bases his studies in a world view context and has touched upon the contributions of other civilization on China. He also touches upon the Indian contributions in cavalry equipment and the gun powder epic[18] and about Navigation[19].

Water lifting devices were one of the important technological achievements in man's quest for progress. Ancient Indians were the first to introduce the water lifting devices. There is definite and conclusive evidence that water pot device – *chakkavattaka* or *Ghati Yantra*, an Indian term for Noria - the water lifting device, existed in India as early as 4th Century BC. Needham describes[20] two forms of water lifting devices the Noria and Saquia, and further elaborates that Noria is a water lifting device that contains fixed pots or containers on the rim of the wheel and Saquia on the rope or the chain flung over the wheel. He further says, based on the works of two other scholars Ananda Coomarsamy[21] and Laufer that India was the country where the Noria originated from[22].

In India water lifting devices were referred to as *chakkavattaka* (turning wheel) during the *Cullavagga Nikaya* period (assigned to 350 BC). It was one of the three permissible models for water lifting. Another term *arahattaghatiyantra* ("A well-wheel with water-pots attached to its spokes") has also been used in ancient Indian texts for water lifting devices. It is clear that since *ara* means "spoke" and *ghata*, means "earthern pot", *araghata* or, in its Prakrit forms, *arahatta* or *arahattaghati*, must mean a wheel "with earthen pots on the spokes". This definition substantiates that chakkavattaka refers to the Noria. Noria and Saquia the two water lifting devices, have been depicted in the gallery using diorama setting type display (fig 8).

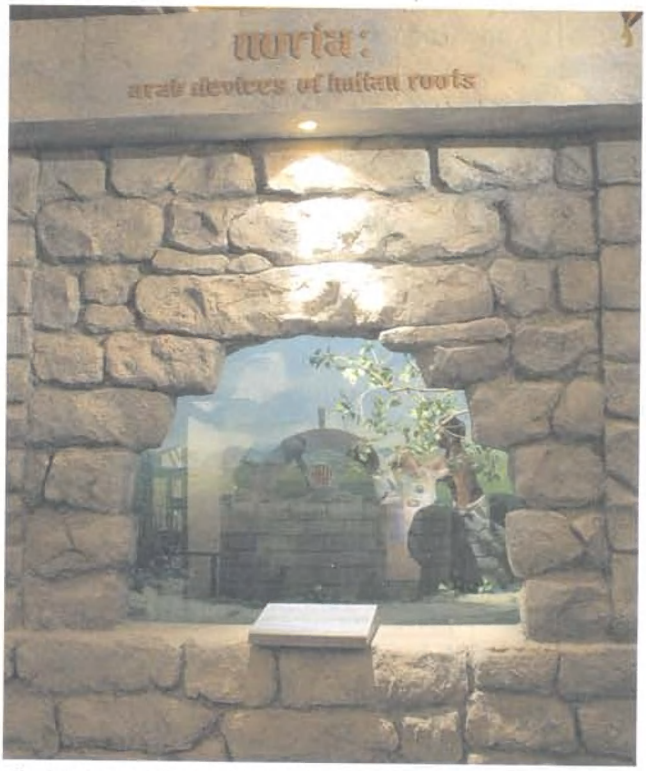


Fig 8. Diorama showing the early water wheels in India, the chakkavattaka or ghatiyantra called the Noria an Arab water lifting device which has its origin from India

## *Worm Gearing and Crank*

Needham[23] also proposed that the worm gearing device, a highly technologically significant device and the most ancient form of rolling mill, originated in India. His argument was based on the presence of the *charkhi* or cotton-gin, with two elongated worms serving to turn its rollers in opposite directions, in parts of China. Noting its presence in Indo-China and Xinjiang, Needham further

speculated that it reached China from India by two routes, via Burma and Indo-China, in about the fifth century AD and, via Central Asia, in the thirteenth. This would mean that the cotton-gin must have been in use in India before the sixth century AD. Needham's hypothesis of the worm gear originating in India was substantiated by Schlingloff[24] who identified the scene, in an Ajanta painting on the left wall of Cave I to the left of the second cell-door, as one of cotton-processing activities and believed that the painting represented a scotching bow. Ishrat Alam[25] however has rightly identified it with the Indian cotton gin thus establishing the fact that the cotton-gin originated in India before the $6^{th}$ century AD. This aspect of the invention of cotton-gin in India becomes more certain because of the universal acceptance that cotton cultivation began in India and that it dates back to the Harappans times. Research scholars have pointed out that the demand for Harappans cotton by the contemporary communities of Iran and Mesopotemia increased the cultivation of cotton by the Harappans which led to an urban revolution. It is therefore not surprising that the concept of an important technology of use of worm gearing began in India with the introduction of the Cotton-Gin and this aspect of India to be the origin of the cotton-gin is best eschewed in the words of Needham who says ' In this machine (cotton-gin) we must surely recognize the most ancient form of rolling mill, a mechanism destined to have such importance later in metal technology". While presenting this concept in the gallery we have covered the cotton-gin and textiles under single exhibit (fig. 9) and highlighted


Fig 9. Exhibit display showcasing ancient Indian cotton and textiles with information on cotton-gin and also a model of the same in the inset along with other display

the significance of cotton, cotton-gin and also the rich traditional textile heritage that India has. The exhibit also houses a model/replica of an ancient cotton gin made from the references of Needhams book.

(to be concluded in Part II)

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